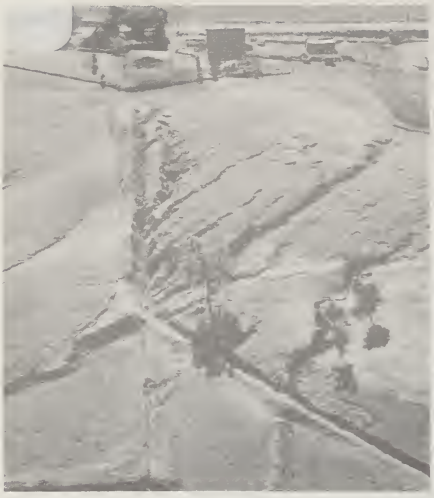
SOIL EROSION

THE WORK OF UNCONTROLLED WATER

AGRICULTURE INFORMATION BULLETIN 260

SOIL CONSERVATION SERVICE

U.S. DEPARTMENT OF AGRICULTURE



IA-2,702; MINN-1,739

SOIL EROSION—
The Work of Uncontrolled Water

When rain falls or water from any source runs downhill on bare soil, it moves soil particles, organic matter, and soluble nutrients. That is soil erosion.

Soil erosion by water may occur anywhere there is enough rain to cause runoff, or where land is flooded by irrigation, snowmelt, or other causes. To avoid erosion, the soil must be protected from moving water. Dense vegetation—cover crops, mulches, grasses, or trees—will intercept rain and slow runoff. Where tillage leaves the soil exposed, barriers like terraces or sown strips of different crops can help control runoff. Otherwise, tillage needs to be confined to nearly level soils where water moves slowly.

Land used for grazing or wood crops also may be eroded by water if harvesting leaves the soil exposed. Too-heavy grazing or careless cutting and burning can do this. But with good management, grasslands and woodlands usually are safe from erosion.

Erosion by water has already damaged much of the farmland in the United States. Some soils inherently unsuited for cultivation, or so badly damaged they cannot be restored, need to be converted to other uses.

On soils kept in cultivation, the prevention of excessive erosion is a major conservation objective. Positive steps to improve the soil and use it efficiently are a part of modern soil conservation. But without protection from erosion, soil-improvement efforts fail.

Erosion control requires the attention of each farmer to his land acre by acre. It also requires cooperation between farmers on adjoining land, for water knows no property boundaries.

UTAH–629

Erosion goes on all the time. Normal erosion occurs where water, wind, or other erosive agents remove soil or rock from slopes that have not been disturbed by man. This is called geologic erosion.

In arid and semiarid regions these processes are rapid and erratic. Infrequent but torrential rains carve the hills and scour the valleys. The sparse vegetation offers little protection. The result is a landscape of angular forms. Flat-topped mesas and concave slopes are characteristic.

In humid and subhumid regions, the soil is held in place by dense forests and prairies. Here normal erosion is usually less rapid than soil formation. Hilltops are rounded and slopes are gently curved. Sharp angles and straight lines in the landscape are unusual.

GA–D3–150

The first settlers found the land in general equilibrium with the climate—though the Southern Piedmont had entered a new erosion cycle before the settlers came and the climate of the Southwest had been getting drier and the vegetation weaker. But as the settlers cleared away the vegetation to grow crops or as they cut the timber or let their livestock overgraze the grasslands, erosion speeded up. It is this "accelerated" or manmade erosion that we are concerned with in today's agriculture. Our problem is to hold down the rate of manmade erosion to one that approaches the normal rate of geologic erosion while the land is used for agriculture.

The small watershed is the natural land unit for controlling water and preventing erosion. What happens in each small watershed affects the land and people in the valley below.

The damage starts where the rain falls. As runoff moves downslope, it grows in volume and in erosive force. Control is easiest if planned from ridge to river.

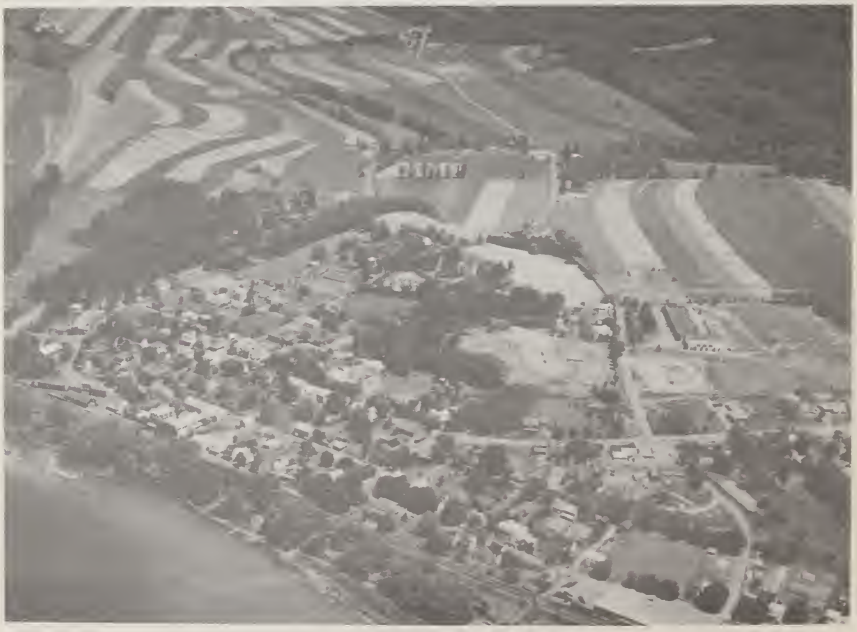
Bottom-land farmers are concerned with erosion on the uplands. Soil washed from the slopes may cover their crops. It may deposit infertile materials on good land and impair the drainage of their fields.

City dwellers, too, are affected by erosion. Silt chokes streams and fills reservoirs; it pollutes water supplies and depletes storage; it destroys wildlife and recreational values.

Unchecked runoff from big rains pyramids into floods that damage both farm and city property and endanger livestock and human lives.

Farm and city people can cooperate in dealing with these related problems through watershed-protection and flood-prevention projects planned for entire watersheds. Some soil conservation districts and municipalities join to sponsor such projects.

ATB-PA-1



C–2,072; C–2,173; NC–2,026

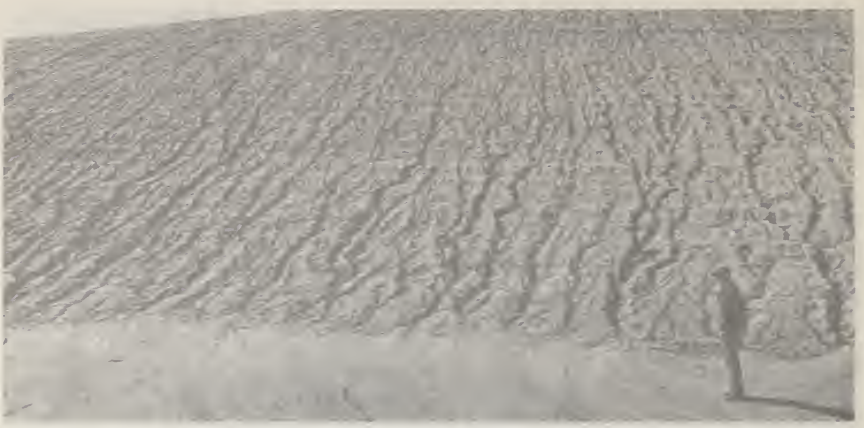
The process of soil erosion by water consists of three principal steps: (1) Loosening soil particles by the impact of raindrops or by the scouring action of runoff, (2) moving the detached particles by flowing water, and (3) depositing the particles at new locations. These steps occur in sequence from ridge to river in a watershed.

Raindrops strike with enough force to tear clumps of unprotected soil apart and separate the tiny particles from each other. They splash the bits of soil about and gradually move them downslope.

Whenever the rain falls faster than it can soak in, a sheet of water collects on the surface and moves downhill. The rain continues to dislodge soil and keep it suspended in the moving sheet or feed it into the little streams of water flowing off the field along crop rows or rills. Mineral nutrients and organic matter are churned into the runoff and carried away, leaving the coarser, less fertile particles behind.

The combined actions of beating rain and flowing water remove continuous layers of soil from fields. This is called *sheet erosion*.

WN–245



ORE-75,165

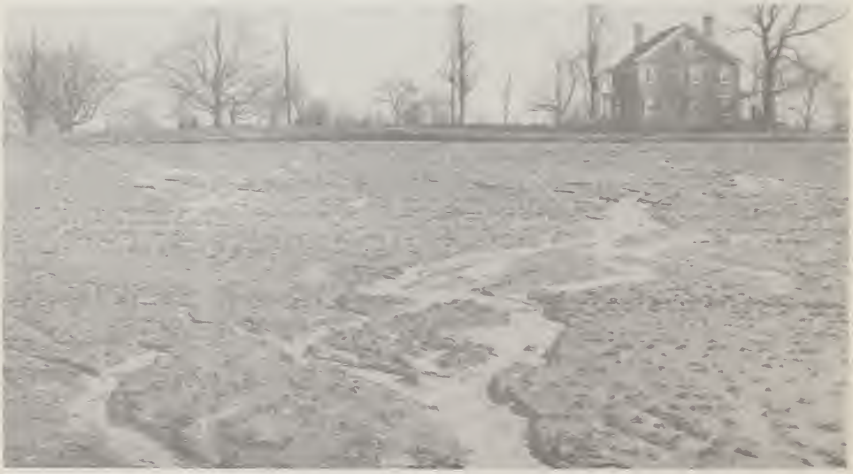
On rolling land, soil is removed more rapidly from the hilltops and steep slopes than from the gentle ones lower down, often exposing lighter colored subsoil as erosion progresses. But sheet erosion takes place wherever muddy water moves off a field during a rain without ponding.

If the water in the little streams moves fast enough, it, too, dislodges soil and carries it along with that splashed up by the raindrops. This scouring action carves out channels that join farther down the slope. This is called *rill erosion*.

The little streams or rills carry more soil as they pick up speed or grow in size. The abrasive particles they carry help scour the sides and bottoms of the channels. Sheet and rill erosion in combination remove enormous amounts of soil from unprotected fields.

Further cultivation smooths the rills and mixes subsoil with the surface layer. The result in most soils is a surface layer harder to work and less productive than the original one.

NJ-30,004

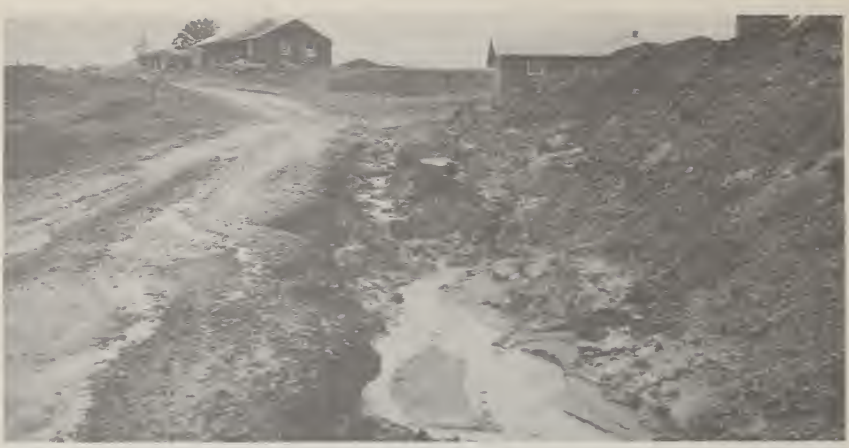


BN-35,547: IDA-45,368

As the rills join to make larger channels the runoff becomes more and more concentrated as it moves downslope and its scouring action increases.

A sudden drop, or "overfall," in the channel multiplies the cutting power of the stream and enlarges the channel as the overfall advances upstream. Channels so deep they cannot be smoothed out by ordinary cultivation are called *gullies*. They feed large amounts of sediment into streams and reservoirs.

MINN-739-A



MD-30,520

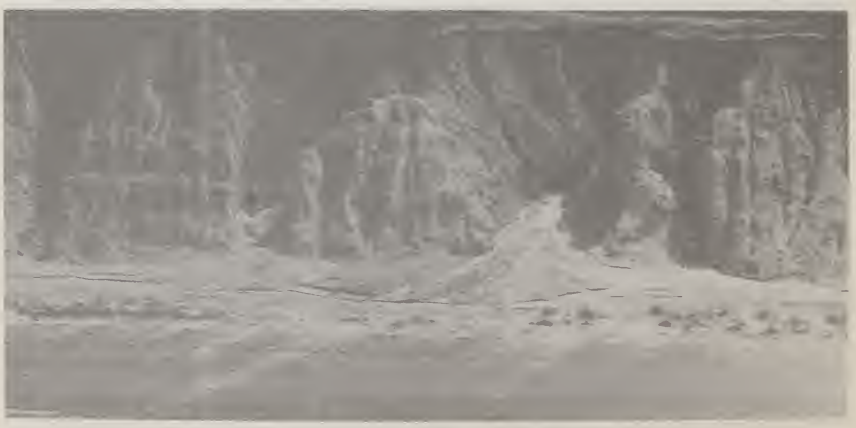
Gullies often are a sign that sheet and rill erosion have been going on a long time. Sometimes they divide fields into small areas impractical to cultivate, even where erosion is not serious between the gullies.

The banks of some large gullies slump and cave. This is especially likely to happen if the soil is underlain by a deep crumbly material. As the plunging stream of water undercuts the head and sides of the gully, great masses of soil break loose and are swept downstream.

In this way gullies advance rapidly across some fields and often make otherwise productive land impossible to farm.

When erosion is active on the uplands of a watershed, the stream that drains the watershed may be cutting away its banks also. This usually is the result of more floodwaters than normal from the unprotected watershed and the scouring action of the sediment load in the stream. Construction sites, unprotected roadbanks, and highways without adequate measures for erosion control can contribute sediment composed of clay, silt, sand, rock, and other material that is transported by flowing water.

GA-D1-226



CAL–5,914

The final step in the erosion process is the deposition of the soil particles that have been moved. This sediment deposit may occur in upland fields or on bottom lands where it damages crops.

Or the sediment may fill streams, ponds, and reservoirs. In any event, deposition of the soil where it is not wanted may be as damaging as its removal from its original position on the watershed. At least 4 billion tons of sediment are produced through erosion in the United States annually. Of the 2 billion tons of sediment washed into streams, about a billion tons reach tidewater.

MD–30,567

Soils built up this way, such as alluvial fans or deltas, are especially subject to gullying.

The National Resources Inventory (NRI) conducted by the U.S. Department of Agriculture, Soil Conservation Service (SCS) in 1977 shows that erosion control measures are needed on more than 177 million acres of cropland, or about 43 percent of the 413 million acres used for cropland. After erosion control measures are applied to cropland, constant attention is needed to keep them working effectively.

The seriousness of the problems resulting from erosion depends largely on the kind of soil that is left.

Every soil is dynamic. It is always changing as water comes and goes and plants and animals live and die. Wind, water, ice, and gravity move soil particles about—sometimes rapidly, sometimes slowly. But even though a soil is never exactly the same for any measurable time, the layers in most soils stay much the same for the span of a human lifetime or much longer unless they are changed by erosion.

Soil erosion can remove in a few years, or sometimes in a few hours, the surface soil that was formed during hundreds or thousands of years.

In nearly all soils the surface layer contains the main supply of organic matter. The depth of this layer ranged from less than an inch to as much as 18 inches in different soils before they were plowed.

Organic matter is the chief source of nitrogen other than that supplied in fertilizers. It also helps bind the soil particles into crumbs that leave space for air and water to move and may be a source of other essential plant nutrients. Loss of surface soil with its organic matter is costly, even if the exposed subsoil is one that can be made productive.

The NRI data show that the estimated average sheet and rill erosion rate for all cropland is 4.7 tons per acre. The rate ranges from less than 1 ton per acre in some states to more than 40 tons per acre for Puerto Rico and the Virgin Islands.

In 22 states the average annual erosion rate for cropland is 4 tons or more per acre. These states are mainly in the central and eastern part of the United States and in Puerto Rico and the Virgin Islands.

On more than 205 million acres, nearly half of the 1977 cropland, the average annual erosion rate is less than 2 tons per acre. Part of this land is level enough that it is not eroded easily, and part has been protected by proper conservation treatment.

In four crop production regions—the Corn Belt, the Delta States, the Appalachian States, and the Southeastern States—more than 35 percent of the cropland is eroding at rates exceeding 5 tons per acre per year. Puerto Rico and the Virgin Islands also have more than 35 percent of their cropland eroding at excessive rates.

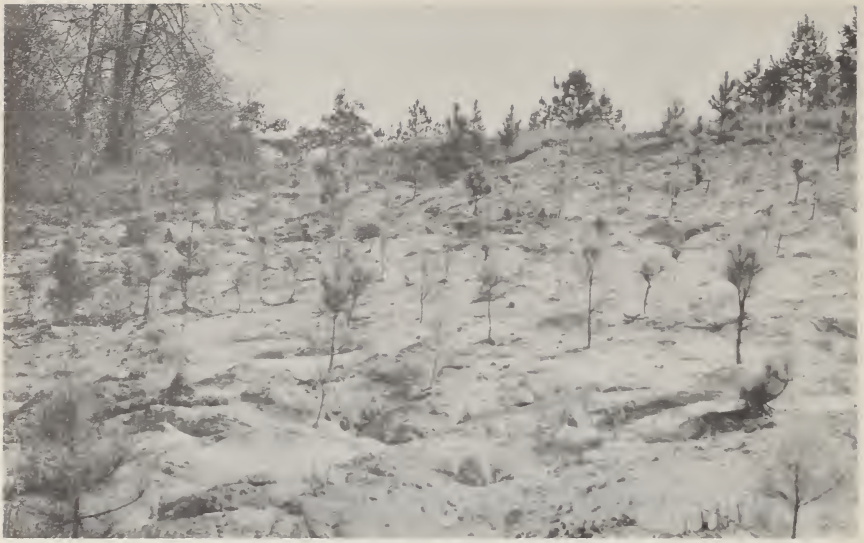
Between the two extremes of severe erosion and slight or no erosion is a great deal of soil with moderate erosion. This may include many small areas that are severely damaged and others that have been protected or are not subject to erosion.

Erosion damages some soils more than others. The degree of damage depends on the nature and depth of the subsoil and underlying material.

WVA-676

About 11 percent of the soils used for crops in the United States are sloping and shallow over rock or other material that is not suitable to be worked into a new plow layer when the present surface soil is lost. In addition, some of the underlying shales and sandstones are acid and low in nutrients. Thus the hazards of erosion are great.

NY-24,159



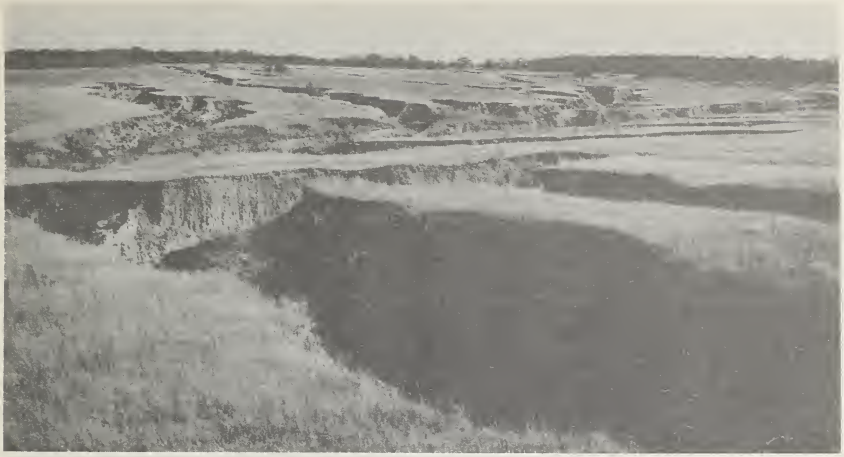
GA–D13–104

Because of the shallow soils, terraces usually are impractical. Badly eroded fields can be used only for permanent vegetation. In humid areas, they usually are best suited to reforestation although they may make only fair woodland sites. In drier regions these fields can be reseeded to grasses for range.

Sloping soils with dense subsoils make up about 37 percent of the land used for crops. Severe erosion can make these soils unfit for cultivation.

On sloping areas surface soils usually are highly erodible. Subsoils generally are of sandy clay, clay, or clay loam texture. When exposed by erosion, they are difficult to work. They are likely to be puddled when wet and cloddy when dry. A crust forms easily on the surface, slowing the intake of water and increasing runoff and erosion.

SC–117; MO–2,025



TEX-49,801

Severe erosion leads to abandonment of fields. Gullies usually are V-shaped in cross section unless they cut through a tough subsoil into a soft and crumbly material. Then they are likely to have vertical or caving sides and be U-shaped.

A combination of conservation practices with good crop rotations is needed to prevent these gullies and keep the soil permanently in cultivation. Terraces and grassed waterways are useful on sloping fields. Sown crops and deep-rooted legumes are needed to keep the soil in good condition for plants to grow.

Poor physical condition, rather than loss of mineral nutrients, is the chief cause of declining yields as erosion advances. Many of the subsoils are about as well supplied with mineral nutrients as the original surface soil. Good pastures can be established on many fields where cultivation is no longer practical.

SC-2,006

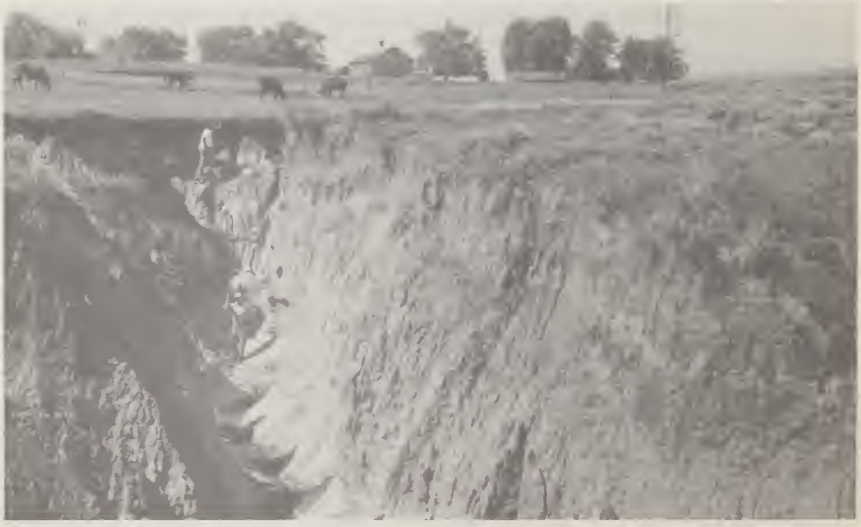
NEB-16,101

Soils with friable subsoils are damaged least by sheet erosion. Sloping soils of this kind make up 19 percent of the land used for crops.

Although these soils are subject to erosion, their subsoils are easily worked and do not differ greatly from the surface soils in texture or mineral content. Many of them have been developed from or are underlain by more or less calcareous windblown sediments, soft lime-bearing shale, moderately permeable glacial drift, or volcanic ash. These materials can be made productive even where erosion has been severe, although several years may be required.

These soils do not have an erosion-resistant layer near the surface and are cut away rapidly by running water. Deep gullies with nearly vertical sides are formed quickly. The cut banks then withstand the action of rain and may remain fairly stable for many years.

MO-1,852



ND–589

Soils like these respond well to good treatment and can be kept permanently productive with a soil conservation program. Some need lime and fertilizer for highest yields. They make good use of the water that falls on them or is applied by irrigation.

It is especially important to keep vegetation in waterways to prevent gullies. Should gullies form, however, they can be smoothed out and the eroded fields restored to pasture or crops.

Although exposed subsoils are lower in nitrogen and organic matter than original surface soils, growing perennial grasses and legumes or other soil-improving crops will help restore productivity. Large gullies that are smoothed out need to be planted to grass and used as waterways because of the danger of further erosion.

MO–1,959

IND–60,629

Level or nearly level soils, not subject to much damage by water erosion, make up about 33 percent of the present cropland in the United States. Although soil splash and surface flooding cause loss of fertility when these soils are left bare, the rate of loss is slow enough that it can be offset by conservation cropping systems.

Man can change the protective cover on soils, the structure of some surface soils, and the behavior of flowing water. He can break the length of a slope and thereby help control runoff by contour rows, stripcropping, terraces, and diversions. He can add plant nutrients but cannot, as a rule, change many qualities of the soil itself, the steepness of slope, or characteristics of the rainfall; he must learn to work with these as they are.

These and other inherent qualities of the soil are summarized in various soil interpretations. Any farmer can get a soil map as a part of his conservation plan through his soil conservation district.

If the farmer or rancher selects a suitable use for each kind of soil within its capability, and applies the right combination of conservation practices, he can take cultivated crops or other products from most kinds of soil and still hold losses by erosion to a limit that can be tolerated.

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